IES Practice Guide - Response to Intervention in Mathematics

A Focus on Assessment

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Assisting Students Struggling with Mathematics: Response to Intervention for Elementary and Middle Schools

The report is available on the IES website:

http://ies.ed.gov/ncee &
http://ies.ed.gov/ncee/wwc/publications/practiceguides/

Panelists

- Russell Gersten (Chair)
- Sybilla Beckman
- Ben Clarke
- Anne Foegen
- Laurel Marsh
- Jon R. Star
- Bradley Witzel

Search for Coherence

Panel works to develop 5 to 10 assertions that are:

- Forceful and useful
- And COHERENT
- Do not encompass all things for all people
- Do not read like a book chapter or article

Challenges for the panel:

- State of math research
- Distinguishing between tiers of support

Jump start the process by using individuals with topical expertise and complementary views

Structure of the Practice Guide

- Recommendations
- Levels of Evidence
- How to carry out the recommendations
- Potential Roadblocks & Suggestions

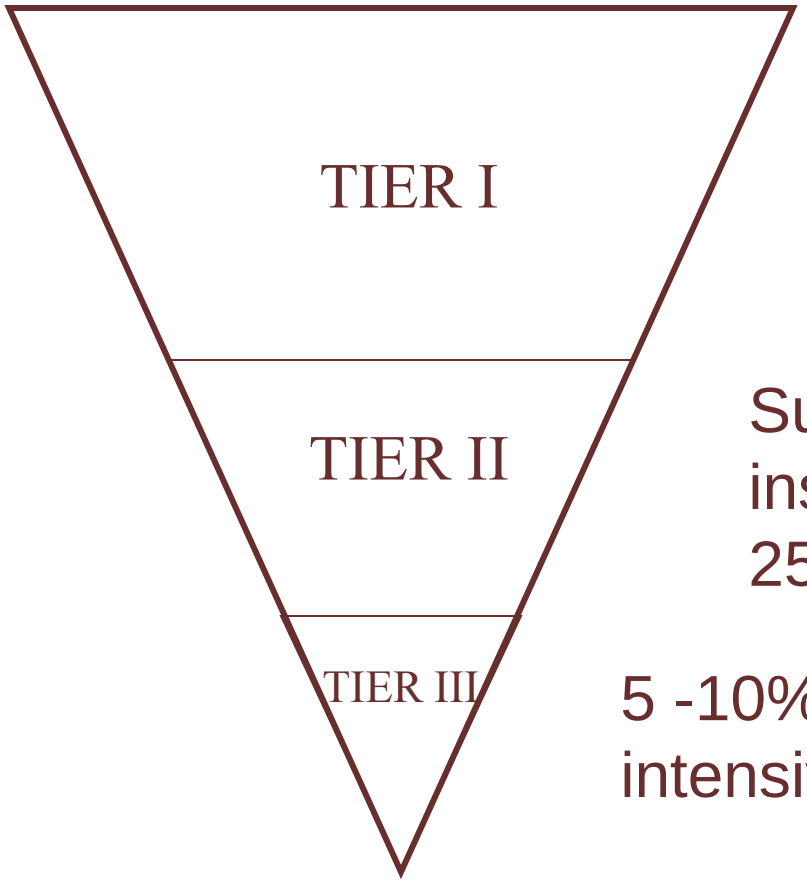
The Research Evidence

- The panel considered:
  - High quality experimental and quasi-experimental studies.
  - Also examined studies of screening and progress monitoring measures for recommendations relating to assessment.

Evidence Rating

- Each recommendation receives a rating based on the strength of the research evidence.
  - Strong
  - Moderate
  - Low

RTI Model



Effective classroom instruction for all students.

Supplemental small group instruction. Typically between 15-25% of students.

5 -10% of students receive the most intensive instruction.

Recommendation	Level of Scientific Evidence
1. Universal screening (Tier I)	Moderate
2. Focus instruction on whole number for grades k-5 and rational number for grades 6-8	Low
3. Systematic instruction	Strong
4. Solving word problems	Strong
5. Visual representations	Moderate
6. Building fluency with basic arithmetic facts	Moderate
7. Progress monitoring	Low
8. Use of motivational strategies	Low

Recommendation 1

Screen all students to identify those at risk for potential mathematics difficulties and provide interventions to students identified as at risk.

- Level of Evidence: **Moderate**

Recommendation 2

Instructional materials for students receiving interventions should focus intensely on in-depth treatment of whole numbers in kindergarten through grade 5 and on rational numbers in grades 4 through 3. These materials should be selected by committee.

- Level of Evidence: **Low**

Evidence

- Consensus across mathematicians, professional organizations, and research panels
  - Milgram and Wu (2005) covering fewer topics with greater depth
  - National Council Teachers of Mathematics (NCTM) and National Mathematics Advisory Panel (NMAP)

Suggestions

- For tier 2 and 3 students in grades k-5, interventions should focus on the properties of whole number and operations. Some older students would also benefit from this approach.

- For tier 2 and 3 students in grades 4-8, interventions should focus on in depth coverage of rational number and advanced topics in whole number (e.g. long division).

Suggestions

- Districts should appoint committees with experts in mathematics instruction and mathematicians to ensure specific criteria are covered in-depth in adopted curriculums.
  - Integrate computation with problem solving and pictorial representations
  - Stress reasoning underlying calculation methods
  - Build algorithmic proficiency
  - Contain frequent review of mathematical principles
  - Contain assessments to appropriately place students in the program

Recommendation 3

Instruction during the intervention should be explicit and systematic. This includes providing models of proficient problem-solving, verbalization of though processes, guided practice, corrective feedback, and frequent cumulative review.

- Level of Evidence: **Strong**

Recommendation 4

Interventions should include instruction on solving word problems that is based on common underlying structures.

- Level of Evidence: **Strong**

Recommendation 5

Intervention materials should include opportunities for the student to work with visual representations of mathematical ideas and interventionists should be proficient in the use of visual representations of mathematical ideas.

- Level of Evidence: **Moderate**

Recommendation 6

- Interventions at all grades should devote about 10 minutes in each session to building fluent retrieval of basic arithmetic facts.
  - Level of Evidence: Moderate

Recommendation 7

- Monitor the progress of students receiving supplemental instruction and other students who are at risk
  - Level of evidence: Low

Recommendation 8

- Include motivational strategies in tier 2 and tier 3 interventions.
  - Level of Evidence: Low

Evidence

- Nine studies met WWC standards or met standards with reservations.

Discussion

Which aspects of the report are surprising?

- Recommendations
- Levels of evidence
- Suggestions

Discussion

Which recommendations from the Practice guide are the highest priority for you? Why?

Discussion

From where you sit in your current job, was the presentation consistent with how you think about RtI?

Why? Why not?

What is Assessment?

Def:

Assessment is the collection of data to make decisions.

(Salvia & Ysseldyke, 1997)

Assessment is useless if we don't use it to guide our actions.

Assessment for Different Purposes

- An effective, comprehensive mathematics assessment program includes assessments for four purposes:
  - Outcome
  - Screening
  - Progress Monitoring
  - Diagnostic

Outcome Assessment

- Purpose: To determine level of proficiency in relation to norm or criterion.
- When: Typically administered at end of year. Can be administered pre/post to assess overall growth.
- Who: All students
- Relation to instruction: Provides index of overall efficacy but limited timely instructional information.

Screening Assessment

- Purpose: To determine children who are likely to require additional instructional support (predictive validity).
- When: Early in the academic year or when new students enter school. May be repeated in the Winter and Spring.
- Who: All students
- Relation to instruction: Most valuable when used to identify children who may need further assessment or additional instructional *support*.

Progress Monitoring Assessment

- Purpose: Frequent, timely measures to determine whether students are learning enough of critical skills.
- When: Weekly or Monthly
- Who: At-risk students
- Relation to Instruction: Indicates student response to instruction.

Diagnostic Assessment

- Purpose: To provide specific information on skills and strategy needs of individual students.
- When: Following screening or at points during the year when students are not making adequate progress.
- Who: Selected students as indicated by screening or progress monitoring measures or teacher judgment.
- Relation to Instruction: Provided specific information on *target skills*; highly relevant.

Coherent Assessment Systems

- Each type of assessment has a purpose
- The design of the tool should match the purpose
  - What are the implications for screening tools used with all students?
- Think purpose not tool
- How do each of these purposes fit together?

Does your school collect data to make decisions or to collect data?

- Common pitfalls
  - Focus is on procedure
  - Data collected don’t match purpose for collecting data (e.g. collecting diagnostic data on all students)
  - Layering of data sources
  - Different data for different programs (e.g. Title 1)

Activity: Do your current assessments function as a whole?

- Talk with a colleague about how the four types of assessments work in one system at your school/district.
  - Does each assessment tool match the purpose it is used for?
  - Does the system link together in a logical manner?

Recommendation 1

Screen all students to identify those at risk for potential mathematics difficulties and provide interventions to students identified as at risk.

- Level of Evidence: **Moderate**

Technical Evidence

- Correlational design studies
  - Greater evidence in the earlier grades
  - Reliability typically included inter-tester, internal consistency, test-retest, and alternate form
    - Most fall between r=.8 to .9
  - Validity primarily focused on criterion related with an emphasis on predictive validity
    - Most fall between r=.5 to .7
  - Measures are beginning to report on sensitivity and specificity

Content

- Content of Measures
  - Single aspect of number sense (e.g. strategic counting) – most common in earlier grades
  - Or Broad measures incorporating multiple aspects of number
    - Some measures are combination scores from multiple single aspect measures
  - Measures reflecting the computation and concepts and applications objectives for a specific grade level – most common later grades
    - Often referred to as CBM or General Outcome

Content

- Promising measures include
  - Word problems
  - Pre-algebra and algebra skills
  - Based on state standards or NCTM/NMAP benchmarks

Features

- Short duration measures (1 minute fluency measures)
  - Note many measures that are short duration also used in progress monitoring.
- Longer duration measures (untimed up to 20 minutes) often examine multiple aspects of number sense
  - Issue of purpose is critical to examine
- Most research examines predictive validity from Fall to Spring.

Examples: Single aspect number sense

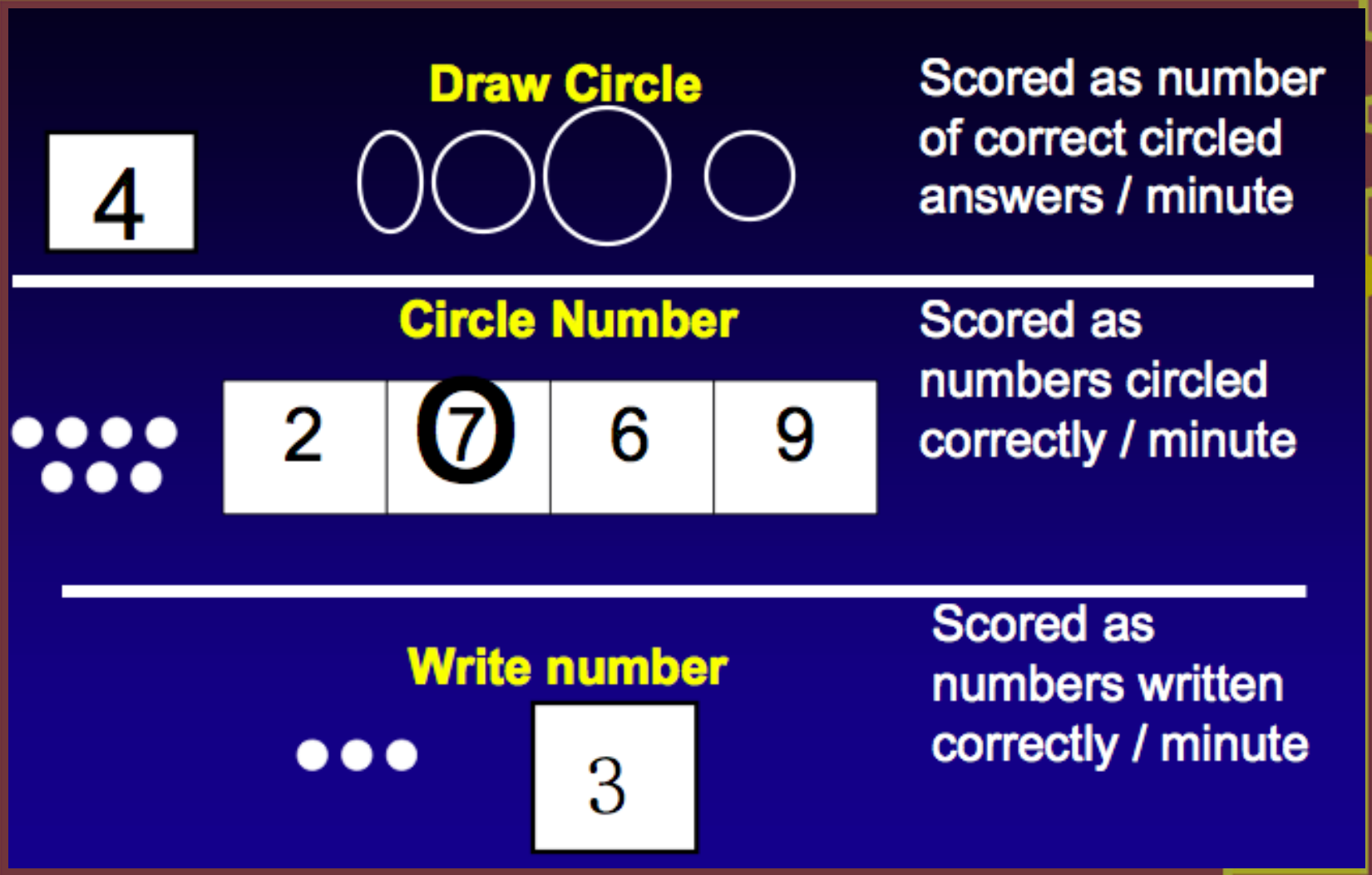
- Example: Magnitude comparison

12 3	4 1	5 11	9 4

- Example: Strategic counting

__ 13 14	6 __ 8	3 4 __

VanDerheyden: K-CBM



Example: Multiple aspects number sense

- Number Knowledge Test
  - Level 1
    - If you had 4 chocolates and someone gave you 3 more, how many chocolates would you have?
    - Which is bigger: 5 or 4?
  - Level 3
    - What number comes 9 after 999?
    - Which difference is smaller: the difference between 48 and 36 or the difference between 84 and 73?

2nd grade and above: Examples

- Number combinations
- Word problems
- Grade level computation objectives
- Grade level concepts and applications
- Measures tied to NMAP Focal Points

General Outcome: Computation objectives

- For students in grades 1–6.
- Student is presented with 25 computation problems representing the year-long, grade-level math curriculum.
- Student works for set amount of time (time limit varies for each grade).
- Teacher grades test after student finishes.

Test 1

Computation 1

Name: _____ Date: _____

A 0 + 3	B 9 - 7	C 0 + 7	D 54 +33	E 7 + 3
F 10 - 0	G 8 + 1	H 2 + 5	I 6 - 3	J 8 - 5
K 11 - 1	L 8 - 1	M 10 - 7	N 2 6 + 1	O 6 - 2
P 65 +23	Q 45 - 4	R 5 + 1	S 8 1 + 1	T 7 - 5
U 8 + 1	V 99 - 8	W 10 - 3	X 7 + 3	Y 9 + 1

General Outcome: Concepts and Applications

- For students in grades 2–6.
- Student is presented with 18–25 Concepts and Applications problems representing the year-long grade-level math curriculum.
- Student works for set amount of time (time limit varies by grade).
- Teacher grades test after student finishes.

Name _____ Date _____ Test 1 Page 1

Column A — Applications 1 — Column B

(1)

Tickets Sold

Jenny	▭ ▭ ▭ ▭ ▭
Antonio	▭ ▭ ▭
Alex	▭ ▭ ▭ ▭
Krystal	▭ ▭

▭ = 1 ticket

How many tickets did Krystal sell?

_____

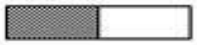
(2)

What number comes after 28?

28 _____

(3)

Write the letter for the shaded part in each blank.

_____ 

(A) $\frac{1}{2}$

(B) $\frac{1}{4}$

_____ 

(C) $\frac{1}{3}$

(4)

Of these numbers,

71 34 39

_____ is the smallest.

_____ is the largest.

(5)

Write + or - in the blank.

5 _____ 2 = 7

(6)

A B C D E F G H I J K L

Write the ninth letter. _____

(7)

Write the time.

_____ : _____

Example: Reflecting critical math content

- easy-CBM
- Items created according to NCTM Focal Points for grade level
- 48 items for screening (16 per focal point)
- Ongoing research (not reviewed in practice guide)

easy-CBM: Number and Operations

Previous

Next

A sack has 4 apples and 7 oranges.
You pick out one fruit.

What is the chance it is an apple?

- $\frac{4}{11}$
- $\frac{7}{11}$
- $\frac{4}{7}$
- I don't know

Next

Middle School

- Algebra measures
  - Designed by Foegen and colleagues assess pre-algebra and basic algebra skills. Administered and scored similar to Math-CBM
- Math CBM Computation and Concepts and Applications
  - Concepts and Applications showed greater valdity in 6th, 7th, and 8th grade

Basic Skills (in Algebra)

- 60 items; 5 minutes
- Problems include:
  - Solving basic fact equations;
  - Applying the distributive property;
  - Working with integers;
  - Combining like terms;
  - Simplifying expressions;
  - Applying proportional reasoning
- Scoring: # of problems correct

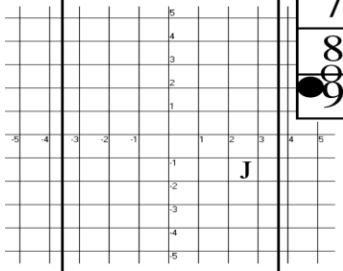
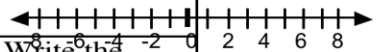
Basic Pre-algebra skills

Solve: $9 + a = 15$ $a =$	Solve: $10 - 6 = g$ $g =$
Evaluate: $12 + (-8) + 3$	Simplify: $9 - 4d + 2 + 7d$
Simplify: $2x + 4 + 3x + 5$	Simplify: $5(b - 3) - b$
Solve: $12 - e = 4$ $e =$	Solve: $q \bullet 5 = 30$ $q =$
Simplify: $4(3 + s) - 7$	Evaluate: $8 - (-6) - 4$
Simplify: $b + b + 2b$	Simplify: $2 + w(w - 5)$
Solve: $\frac{b}{6} = \frac{12}{18}$ $b =$	Solve: 1 foot =12 inches 5 feet = _____ inches
Simplify: $7 - 3(f - 2)$	Simplify: $4 - 7b + 5(b - 1)$
Evaluate: $-5 + (-4) - 1$	Simplify: $s + 2s - 4s$
Solve: $63 \div c = 9$ $c =$	Solve: $x + 4 = 7$ $x =$
Simplify: $2(s - 1) + 4 + 5s$	Simplify: $-5(q + 3) + 9$
Simplify: $8m - 9(m + 2)$	Evaluate: $9 + (-3) - 8$

Algebra Foundations

- 42 items (50 points); 5 minutes
- Problems represent five core concepts/skills essential to conceptual understanding in algebra
  - Writing and evaluating variables and expressions
  - Computing expression (integers, exponents, and order of operations)
  - Graphing expressions and linear equations
  - Solving 1-step equations and simplifying expressions
  - Identifying and extending patterns in data tables
- Scoring: # of problems correct

Algebra Foundations (B)

Find the ordered pair for each point: J(,) O(,) 	Fill in the empty box: s | $3s$ 6 | 18 7 | 21 8 | 9 | 27	Fill in the empty box: n | $4n + 7$ -1 | 3 -2 | -3 | -5 -4 | -9	Fill in the empty box: b | -2 | -5 0 | -3 3 | 0 5 | 2
If $y > 9$, two possible values for y are _____ and _____	Evaluate: $9 \bullet 4 - 6$	Simplify: $7f + (2f + f)$	Solve: $n + 3 = 8$ $n =$
Evaluate $4b + 2$ when $b = 1$ _____	Write the expression for this phrase: *6 less than a number*	Evaluate: $(-2) \bullet (-4)$	Graph the expression $m > -5$ 
Write a word phrase for this expression: $n + 9$	Evaluate: $4 + (9 \boxplus 3) - 2^2$	Evaluate: $(-2)^3$	Write the expression for this phrase: *9 multiplied*
Evaluate $2x + 4y$ when $x = 2$ and $y = -3$	Write a word phrase for this expression: $10b - 7$	Evaluate $8g - 4$ when $g = 2$ _____ $g = -2$ _____	Simplify: $6 - 2(b - 4)$

Suggestions

- Have a building level team select measures based on critical criteria such as reliability, validity and efficiency.
- Select screening measures based on the content they cover with a emphasis on critical instructional objectives for each grade level.
- In grades 4-8, use screening measures in combination with state testing data.
- Use the same screening tool across a district to enable analyzing results across schools.

Suggestions

- Have a building level team select measures based on critical criteria such as reliability, validity and efficiency.
  - Team should have measurement expertise (e.g. school psychologist) and mathematics (e.g. math specialist)
  - Set up a screening to occur twice a year (Fall and Winter)
  - Be aware of students who fall near the cut scores

Suggestions

- Select screening measures based on the content they cover with a emphasis on critical instructional objectives for each grade level.
  - Lower elementary: Whole Number
  - Upper elementary: Rational Number
  - Across grades: Computational Fluency (hallmark of MLD)

Suggestions

- In grades 4-8, use screening measures in combination with state testing data.
  - Use state testing data from the previous year as the first cut in a screening system.
  - Can then use a screening measure with a reduced pool of students or a more diagnostic measure linked to the intervention program for a second cut.

Suggestions

- Use the same screening tool across a district to enable analyzing results across schools
  - Districts may use results to determine the effectiveness of district initiatives.
  - May also be used to determine systematic areas of weakness and provide support in that area (e.g. fractions)

Roadblocks

- Resistance may be encountered in allocating time resources to the collection of screening data
- Questions may arise about testing students who are “doing fine”.
- Screening may identify students as at-risk who do not need services and miss students who do.
- Screening may identify large numbers of students who need support beyond the current resources of the school or district.

Roadblocks

- Resistance may be encountered in allocating time resources to the collection of screening data.
- Suggested Approach: Use data collection teams to streamline the data collection and analysis process.

Roadblocks

- Questions may arise about testing students who are “doing fine”.
- Suggested Approach: Screening all students allows the school or district to evaluate the impact of instructional approaches
  - Screening all students creates a distribution of performance allowing the identification of at-risk students

Roadblocks

- Screening may identify students as at-risk who do not need services and miss students who do.
- Suggested Approach: Schools should frequently examine the sensitivity and specificity of screening measures to ensure a proper balance and accurate decisions about student risk status.

Sensitivity and Specificity

		Students at-risk	
		YES	NO
Students identified as at-risk	YES	True positive (A)	False positive (B)
	NO	False negative (C)	True negative (D)

Sensitivity: Number of students correctly identified as at-risk or A/(A+C)

Specificity: Number of student correctly identified as not at risk or D/(D+B)

Sensitivity and Specificity

- Set your cut score too high and
  - You have good sensitivity (all kids that need help are identified) but poor specificity (lots of kids who don't need help are identified)
- Set your cut score too low and
  - You have good specificity (most kids who don't need help will not be identified as at-risk) but poor sensitivity (you may miss many kids who do need help)

Roadblocks

- Screening may identify large numbers of students who need support beyond the current resources of the school or district.
- Suggested Approach: Schools and districts should
  - Allocate resources to the students with the most risk and at critical grade levels

    and
  - Implement school wide interventions to all students in areas of school wide low performance (e.g. Fractions)

Consider Recommendation 2

Instructional materials for students receiving interventions should focus intensely on in-depth treatment of whole numbers in kindergarten through grade 5 and on rational numbers in grades 5 through 8. These materials should be selected by committee.

- Level of Evidence: **Low**

Evidence

- Consensus across mathematicians, professional organizations, and research panels
  - Milgram and Wu (2005) covering fewer topics with greater depth
  - National Council Teachers of Mathematics (NCTM) and National Mathematics Advisory Panel (NMAP)

Suggestions

- For tier 2 and 3 students in grades k-5, interventions should focus on the properties of whole number and operations. Some older students would also benefit from this approach.

- For tier 2 and 3 students in grades 4-8, interventions should focus on in depth coverage of rational number and advanced topics in whole number (e.g. long division).

Who will screening identify

- Take 6th grade screening results:
- The lowest quarter of students may have very different instructional needs
- Some students may have a firm grasp on whole number operations and principles (e.g. understand associative, distributive, and commutative laws) but not yet demonstrate that understanding with rational numbers.
- Other students may not understand whole number operations or principles
- These groups of students will have very different instructional needs

Recommendation 7

- Monitor the progress of students receiving supplemental instruction and other students who are at risk
  - Level of evidence: Low

Evidence

- Non-experimental studies demonstrating the technical adequacy of progress monitoring measures.
  - Reliability and Validity are similar to that found for screening measures (often the same measure)
  - Growth has been typically examined by looking at average scores across time
  - Some evidence of use in instructional decision making and improved student outcomes
- Greater evidence in elementary grades

Content and Features

- General outcome measures reflecting concepts and computation objectives for the grade level.
  - Some limited evidence for single aspect measures (i.e. Magnitude comparison)
- All are timed and short duration

Suggestions

- Monitor the progress of tier 2, tier 3 and borderline tier 1 students at least once a month using grade appropriate general outcome measures.
- Use curriculum-embedded assessments in intervention materials
  - Frequency of measures can vary - every day to once every week.

Suggestions

- Monitor the progress of tier 2, tier 3 and borderline tier 1 students at least once a month using grade appropriate general outcome measures.
  - Same team that worked on screening can also work on progress monitoring
  - Need to carefully consider capacity to model growth in the context of instructional decision making

Suggestions

- Use curriculum-embedded assessments in intervention materials
  - Frequency of measures can vary - every day to once every week.
  - Will provide a more accurate index of whether or not the student is obtaining instructional objectives
  - Combined with progress monitoring provides a proximal and distal measuue of performance

Roadblocks

- Students within classes are at very different levels.
- Insufficient time for teachers to implement progress monitoring.

Roadblocks

- Students within classes are at very different levels.
- Suggested Approach: Group students across classes to create groups with similar needs.

Roadblocks

- Insufficient time for teachers to implement progress monitoring.
- Suggested Approach: Train paraprofessionals or other school staff to administer progress monitoring measures.

How to start and Next steps

- As you get started consider
  - Focus on one grade or grade bands
    - Long term trajectories suggest end of K critical benchmark
    - May have more expertise/comfort with whole number approach
  - Screening before progress monitoring
  - Strategies for collecting data

Resources

- NMAP
  - http://www.ed.gov/about/bdscomm/list/mathpanel/index.html
- Center On Instruction - Mathematics
  - http://www.centeroninstruction.org/resources.cfm?category=math
- NCTM focal points
  - http://www.nctm.orfocalpoints.aspxlinkidentifier=id&itemid=270
- PIR website (Best Practices/Articles)
  - http://pacificir2.uoregon.edu:8100/
- National Center Progress Monitoring
  - http://www.studentprogress.org/
- CA Intervention Standards
  - http://www.cde.ca.gov/ci/ma/im/mathprogramnov2007.asp